THE 2004 SUMMER WATER TEMPERATURE AND FLOW MANAGEMENT PROJECT

NECHAKO FISHERIES CONSERVATION PROGRAM

Technical Report No. RM04-1

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February, 2006

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ABSTRACT

The 2004 Nechako River Summer Water Temperature and Flow Management Project (the Project) was undertaken to attempt to prevent mean daily water temperatures in the Nechako River above the Stuart River confluence (at Finmoore) from exceeding 20.0°C (68.0°F) between July 20 and August 20. Water temperatures were managed by regulating Skins Lake Spillway releases to control flows in the Nechako River below Cheslatta Falls and at Vanderhoof. In 2004, mean daily water temperatures in the Nechako River above the Stuart River confluence exceeded 20.0°C (68.0°F) on July 24, 29, and 30, and August 2, 11 and 13 through 20.

Over the duration of the 2004 Summer Water Temperature and Flow Management Project (July 10 to August 20), the total volume of water released was 9,422.7 m³/s-d, (332,762 cfs-d), and the average release during the Project was 224.3 m³/s (7,923 cfs).

INTRODUCTION

The Nechako River Summer Water Temperature and Flow Management Project (the Project) currently in place was designed and developed in 1982 and has been successfully implemented by Triton Environmental Consultants Ltd. (Triton) since 1983. Since 1988, water temperature and flow management projects (Triton 1995a through Triton 1995h, Triton 1996 through Triton 2003) have been carried out under the auspices of the Nechako Fisheries Conservation Program (NFCP).

The objective of the Project is to attempt to prevent mean daily water temperatures in the Nechako River above the Stuart River confluence (at Finmoore) from exceeding 20.0°C (68.0°F). This objective is met by regulating releases from the Skins Lake Spillway to control flows in the Nechako River below Cheslatta Falls and at Vanderhoof. The Project operates from July 10 to August 20 (the operational period) with the goal of managing water temperatures in the Nechako River at Finmoore between July 20 and August 20 (the water temperature control period, hereafter referred to as the control period). These dates may vary as directed by the NFCP in accordance with the timing of sockeye runs in the system. Flows in the Nechako River at Cheslatta Falls are also to be reduced to fall spawning flows by early September.

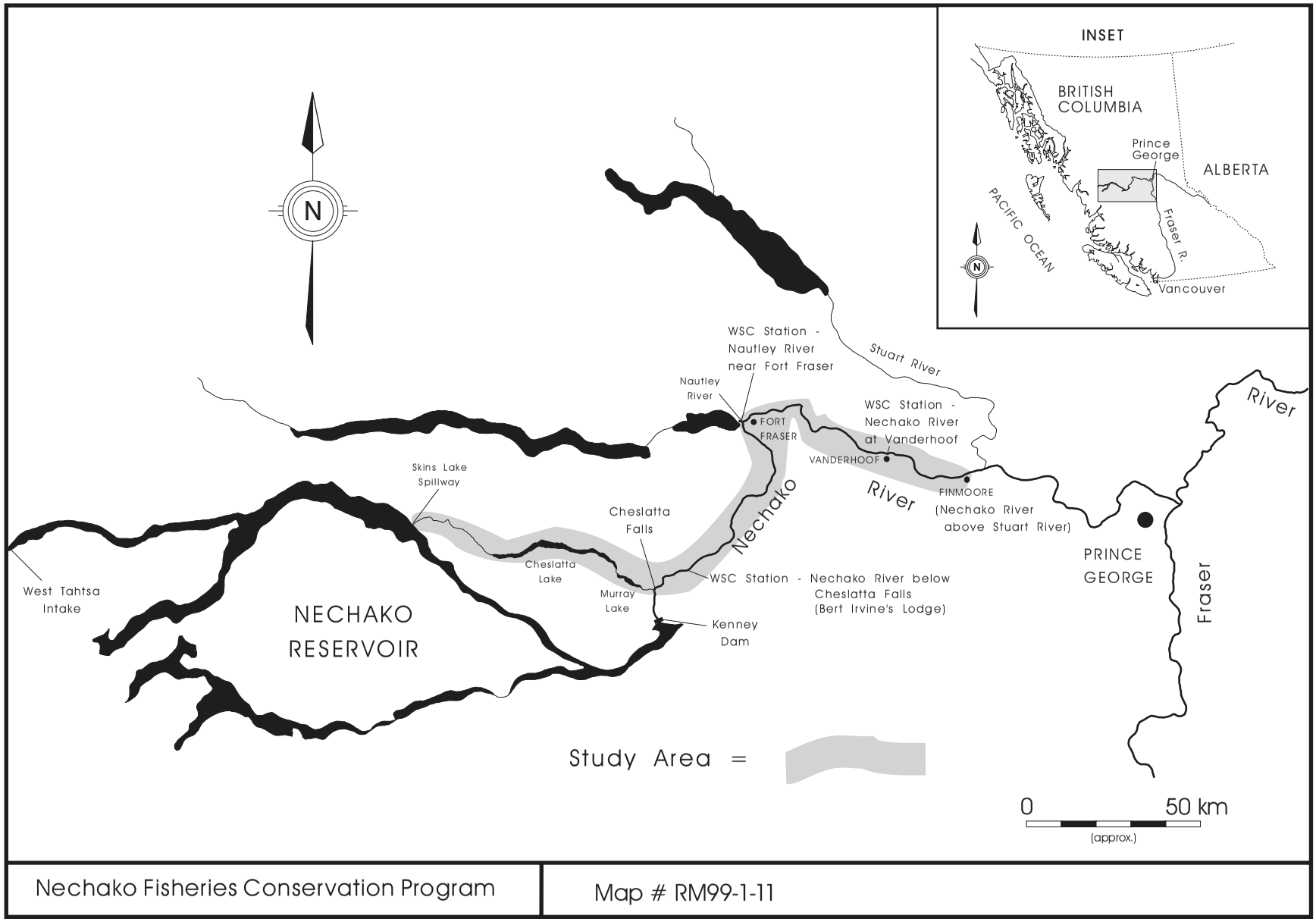
The Project study area is shown in Figure 1. Unless otherwise stated, references to water temperatures, flows (including releases) and meteorological data are mean daily values, and the location of the Nechako River above the Stuart River confluence refers to the Nechako River at Finmoore.

This report reviews the 2004 Summer Water Temperature and Flow Management Project and includes an outline of Triton's method of determining Skins Lake Spillway releases, a summary of Triton's 2004 Skins Lake Spillway release recommendations for the period July 10 to September 6 inclusive, and a summary of recorded flows (July 10 to September 6) and water temperatures (July 10 to August 20) at various locations along the Nechako River. Also discussed is the volume of cooling water used in the 2004 Summer Water Temperature and Flow Management Project.

METHODS

The management of the Nechako River flows and water temperatures was accomplished using water temperature predictions based on five-day meteorological forecasts to determine the schedule of Skins Lake Spillway releases required to meet project objectives. The Summer Water Temperature and Flow Management uses an unsteady-state

FIGURE 1 **Nechako River Study Area**



Nechako Fisheries Conservation Program | Map # RM99-1-11

flow routing model and an unsteady-state water temperature prediction model designed to compute the conditions in the Nechako River defined by the nature of the meteorological conditions. Numerical modelling of flows and water temperatures in the Nechako River was performed daily during the entire operational period.

Daily operations followed the protocol as set out in the Settlement Agreement (Anon. 1987), and involved collection of water temperature and river stage data from several locations in the study area, and development of five-day meteorological forecasts. Water temperatures were obtained daily from recorders maintained in the Nechako River below Cheslatta Falls (at Bert Irvine's Lodge), in the Nechako River at Fort Fraser (upstream of the Nautley River), in the Nechako River above the Stuart River confluence and in the Nautley River. River stages were obtained daily from recorders maintained in the Nechako River below Cheslatta Falls, in the Nechako River at Vanderhoof and from a staff gauge in the Nautley River. Five-day meteorological forecasts were provided by World Weatherwatch as a sub consultant to Triton.

River stage and minimum and maximum water temperature data were obtained daily for each location identified except the Nechako River below Cheslatta Falls, where hourly water temperature and river stage data recorded were obtained from the data collection platform via computer link to Water Survey of Canada (WSC), Vancouver. In addition, spot and corresponding recorded water temperatures were collected at each location visited daily and used to adjust the recorded water temperatures.

The adjustment provided an ongoing check of each thermograph, and was performed in the following manner. If the spot temperature was higher than the thermograph record, the thermograph record was adjusted to agree with the recorded spot temperature for that day. If the thermograph record was higher than the spot temperature, the thermograph record was not adjusted. This procedure was implemented as a conservative measure.

Skins Lake Spillway releases reported are as requested by Triton. All Nechako River and Nautley River flow data reported are preliminary data, and are part of the database utilized in the daily operation of the Summer Water Temperature and Flow Management Project. These data are not updated as it is the preliminary data that was used in real-time modelling of the Nechako River system. Therefore, values presented may differ slightly from those reported by WSC.

The first 10 days of the operational period, July 10 to July 19, were utilized for system start up, for initialization of the database required to schedule Skins Lake Spillway releases and to increase flows in the Nechako River from spring flows to the minimum cooling flow of 170 m^3/s (6,000 cfs) below Cheslatta Falls. The 2004 Skins Lake Spillway spring base release as directed by the NFCP was 53.1 m^3/s (1,875 cfs). Upon commencement of the operational period on July 10, the recorded flow in the Nechako River below Cheslatta Falls was 55.5 m^3/s (1,960 cfs). On July 11, 2004, the Skins Lake Spillway release was increased from the spring base release to 227 m^3/s (8,000 cfs) to ensure flows in the Nechako River below Cheslatta Falls reached the minimum cooling flow of 170 m^3/s (6,000 cfs) by July 20 (the beginning of the water temperature control period).

Throughout the operational period, water temperatures in the Nechako River were calculated daily for the previous day, the current day and each of the next four days using the unsteady-state flow routing and water temperature prediction models. These calculations were based on recorded and five-day forecast meteorological data, recorded water temperature and computed flow data. Forecast water temperature predictions were tabulated and reviewed daily to identify trends in water temperature changes. These trends are the same as those used in the water temperature and flow management projects since 1984 (Envirocon Ltd. 1985), and are best explained through reference to Table 1.

TABLE 1 Daily Operations to Manage Water Temperatures in the Nechako River above the Stuart River Confluence

Date	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul*	17-Jul	18-Jul	19-Jul	20-Jul
Fifth Day's Predicted Water Temperature @ Date + 4 Days								a5	b5	c5
Fourth Day's Predicted Water Temperature @ Date + 3 Days							a4	b4	c4	
Third Day's Predicted Water Temperature @ Date + 2 Days						a3	b3	c3		
Second Day's Predicted Water Temperature @ Date + 1 Day					a2	b2	c2			
Current Day's Predicted Water Temperature @ Date				a1	b1	c1				
Previous Day's Calculated Water Temperature @ Date - 1 Day			as	bs	cs					
Previous Day's Recorded Water Temperature @ Date - 1 Day			ao	bo	co					
Current Day's Release @ Date				ra	rb	rc				

observed trend

predicted trend

forecast trend

* The current day (i.e., the day of operation) for this example is July 16.

Assuming the current day is July 16, entries corresponding to the current day's operation are represented by the letter c. Entries co and cs represent the recorded and calculated water temperatures, respectively, for the previous day (July 15). Entries c1 through c5 represent predicted water temperatures computed using the current day's five-day meteorological forecast and an assumed current day's flow regime. The entry rc represents the current day Skins Lake Spillway release required to meet project objectives.

The following three trends in water temperature changes were reviewed on a day-by-day basis:

1. Observed trend; developed from recorded mean daily water temperatures measured in the Nechako River above the Stuart River confluence each day (bo and co in Table 1). The difference in recorded water temperatures for the previous two days is extrapolated over the next five days to determine the observed water temperature trend.
2. Predicted trend; developed from the predicted water temperatures for the previous day and the following five days (cs, c1, c2, c3, c4, c5, in Table 1). These data represent the predicted trend.
3. Forecast trend; developed from the difference between the current five-day and previous five-day predictions for the same calendar days (c3 and b4, c2 and b3, c1 and b2 in Table 1). Differences between forecasted data on coincident dates for the current day and the next two days only are averaged and added to the fifth day predicted temperature to determine the trend in forecasted temperatures.

A numerical example of how the trends are calculated is presented in Appendix A.

Each day predicted water temperatures for the five-day forecast period were checked and the three trends calculated. If two of the three trends indicated that the water temperature in the Nechako River above the Stuart River confluence could potentially exceed 19.4°C (67.0°F) then an increase in the Skins Lake Spillway release was required. When this occurred the current day's release was revised and the flow and temperature models were rerun using the modified flow regime. Results of each day's final computer run were subsequently used to initialize water temperatures for the following day's computations. Entries in Table 1 represent each day's final cooling water release and resultant predicted water temperatures.

The following release criteria were used with the three trends identified above to determine the timing and magnitude of Skins Lake Spillway releases:

1. When two of the three trends show an increase in water temperature in the Nechako River above the Stuart River confluence, and these trends show that potentially the water temperature could exceed 19.4°C (67.0°F), increase the Skins Lake Spillway release according to criteria 2 and 3 below.
2. Operate Skins Lake Spillway such that flow in the Nechako River below Cheslatta Falls ranges between 170 m³/s (6,000 cfs) and 283 m³/s (10,000 cfs) as required, and flow in the Nechako River above the Stuart River confluence does not exceed 340 m³/s (12,000 cfs). It is understood that the flow in the Nechako River below Cheslatta Falls is to be not less than 170 m³/s (6,000 cfs) by the beginning of the control period, and is to be reduced to approximately 31.2 m³/s (1,100 cfs) by September 6.
3. At any time, increase the Skins Lake Spillway release from the current level to 453 m³/s (16,000 cfs) to achieve the flow changes in the Nechako River as fast as possible.
4. During cooling periods when two of three trends in forecasted water temperatures are decreasing and these trends indicate that potentially the water temperature could drop below 19.4°C (67.0°F) within the forecast period (five days), reduce the Skins Lake Spillway release from the current level to 14.2 m³/s (500 cfs).

TABLE 2 **Predicted and Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, July 10 to August 20, 2004**

	JULY																					
Date	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
5th Day's Predicted Water Temperature at Date + 4 Days					68.7	69.1	69.5	68.3	67.6	67.7	66.6	67.0	67.9	67.7	68.3	69.2	67.8	66.7	66.6	67.2	67.6	66.9
4th Day's Predicted Water Temperature at Date + 3 Days				67.4	68.2	69.8	69.6	68.8	69.1	67.8	67.2	67.4	67.5	67.6	68.7	68.5	68.1	66.5	66.2	67.3	67.5	66.6
3rd Day's Predicted Water Temperature at Date + 2 Days			66.6	66.8	69.2	70.5	70.2	70.8	69.5	68.0	67.7	67.5	67.1	67.6	67.9	69.2	68.0	65.7	66.5	67.6	67.5	68.1
2nd Day's Predicted Water Temperature at Date + 1 Day		65.7	66.0	68.1	70.2	71.0	72.1	71.4	68.9	69.5	68.2	66.8	66.7	66.8	68.9	69.3	66.2	66.1	67.3	68.3	69.3	68.2
Current Day's Predicted Water Temperature at Date	64.7	65.7	67.3	69.5	70.0	71.7	73.1	70.5	71.6	69.6	67.5	66.5	66.6	67.9	69.6	67.7	66.5	67.1	68.2	69.6	69.2	68.7
Previous Day's Calculated Water Temperature at Date - 1 Day	64.5	66.4	67.6	69.4	70.2	71.9	72.8	71.3	71.6	69.4	67.3	66.4	67.0	68.2	68.9	67.8	66.9	67.3	68.5	69.2	69.3	68.6
Previous Day's Recorded Water Temperature at Date - 1 Day	63.9	65.4	67.3	67.8	68.7	71.2	72.5	71.4	70.0	69.0	67.4	66.5	66.7	68.0	69.0	68.0	66.6	66.8	68.0	68.7	68.2	67.9
Current Day's Skins Lake Spillway Release at Date (cfs)	1875	1875 to 8000 @ 1600 hrs	8000	8000	8000	8000 to 16,000 @ 2000 hrs	16,000	16000 to 500 @ 1400 hrs	500 to 16000 @ 1600 hrs	16000	16000 to 10000 @ 2000 hrs	10000 to 9000 @ 1400 hrs	9000	9000	9000 to 500 @ 1400 hrs	500 to 10000 @ 1600 hrs	10000 to 16000 @ 1600 hrs	16000 to 10000 @0800 10000 to 500 @1600 (see Note 1)	500	500 to 16000 @ 1700 hrs	16000 to 500 @ 1600 hrs	500

NOTE 1: SLS release for July 27 - decreased from 453 m³/s (16,000 cfs) to 283 m³/s (10,000 cfs) at 0800 hrs., and then decreased from 283 m³/s (10,000 cfs) to 14.2 m³/s (500 cfs) at 1600 hrs.

TABLE 2 (cont.) **Predicted and Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, July 10 to August 20, 2004**

	AUGUST																					
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
5th Day's Predicted Water Temperature at Date + 4 Days	66.0	66.0	66.0	65.8	65.6	66.2	66.0	66.8	66.7	67.2	67.5	68.3	68.1	68.3	68.4	68.7	68.0	67.7	67.6	67.9	68.0	66.7
4th Day's Predicted Water Temperature at Date + 3 Days	67.0	66.5	66.5	66.0	66.4	66.2	66.2	65.6	65.0	66.4	67.6	68.0	68.5	68.3	68.8	68.7	68.1	68.0	68.0	68.1	67.9	66.0
3rd Day's Predicted Water Temperature at Date + 2 Days	67.0	67.1	66.9	67.0	67.0	66.6	65.2	63.8	65.2	66.5	67.6	68.6	68.5	69.1	69.3	69.0	68.9	68.7	68.3	68.5	67.7	65.7
2nd Day's Predicted Water Temperature at Date + 1 Day	68.1	67.9	68.2	68.3	68.1	66.1	64.6	65.1	66.0	67.9	68.7	68.9	69.7	70.2	70.3	70.6	70.6	68.9	68.9	69.0	67.8	
Current Day's Predicted Water Temperature at Date	68.6	68.7	69.2	68.6	67.9	65.6	66.1	65.8	67.5	68.5	69.1	69.4	70.0	70.4	70.9	71.0	69.7	69.1	69.7	69.7		
Previous Day's Calculated Water Temperature at Date - 1 Day	68.7	69.0	68.9	68.7	67.2	66.3	66.2	65.9	67.5	68.4	69.1	69.2	69.8	70.3	70.6	70.6	69.7	69.3	70.0			
Previous Day's Recorded Water Temperature at Date - 1 Day	67.5	68.1	68.0	67.8	67.4	66.0	65.6	65.8	66.4	67.0	68.1	68.0	68.5	69.0	69.0	68.9	68.5	69.1	70.1	69.3		
Current Day's Skins Lake Spillway Release at Date (cfs)	500 to 8000 @ 1600 hrs	8000	8000 to 6000 @ 1400 hrs	6000	6000	6000	6000 to 16000 @ 2000 hrs	16000	16000	16000 to 500 @1000 500 to 10000 @2000 (see Note 2)	10000	10000	10000	10000	10000 to 9000 @ 1300 hrs	9000	9000	9000 to 500 @ 1200 hrs	500	500		

NOTE 2: SLS release for August 10 - decreased from 453 m³/s (16,000 cfs) to 14.2 m³/s (500 cfs) at 1000 hrs., and then increased from 14.2 m³/s (500 cfs) to 283 m³/s (10,000 cfs) at 2000 hrs.

FIGURE 2

Recorded Mean Daily Temperatures in the Nechako River Above the Stuart River Confluence, July 10 to August 20, 2004

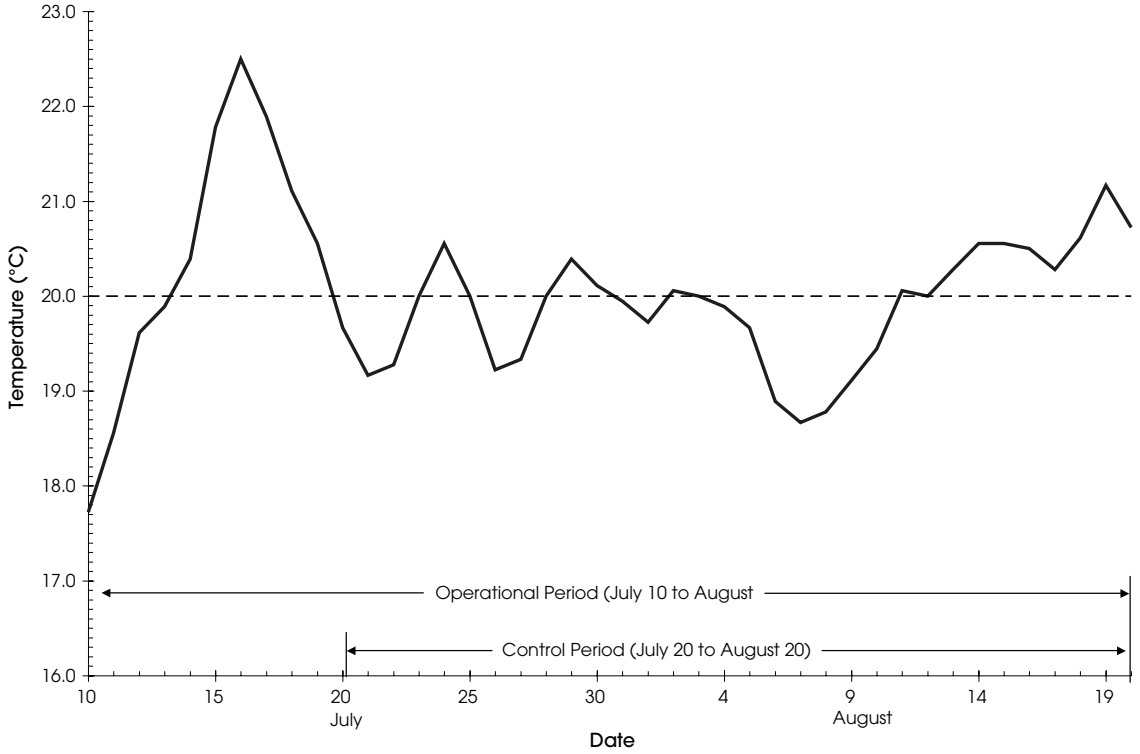
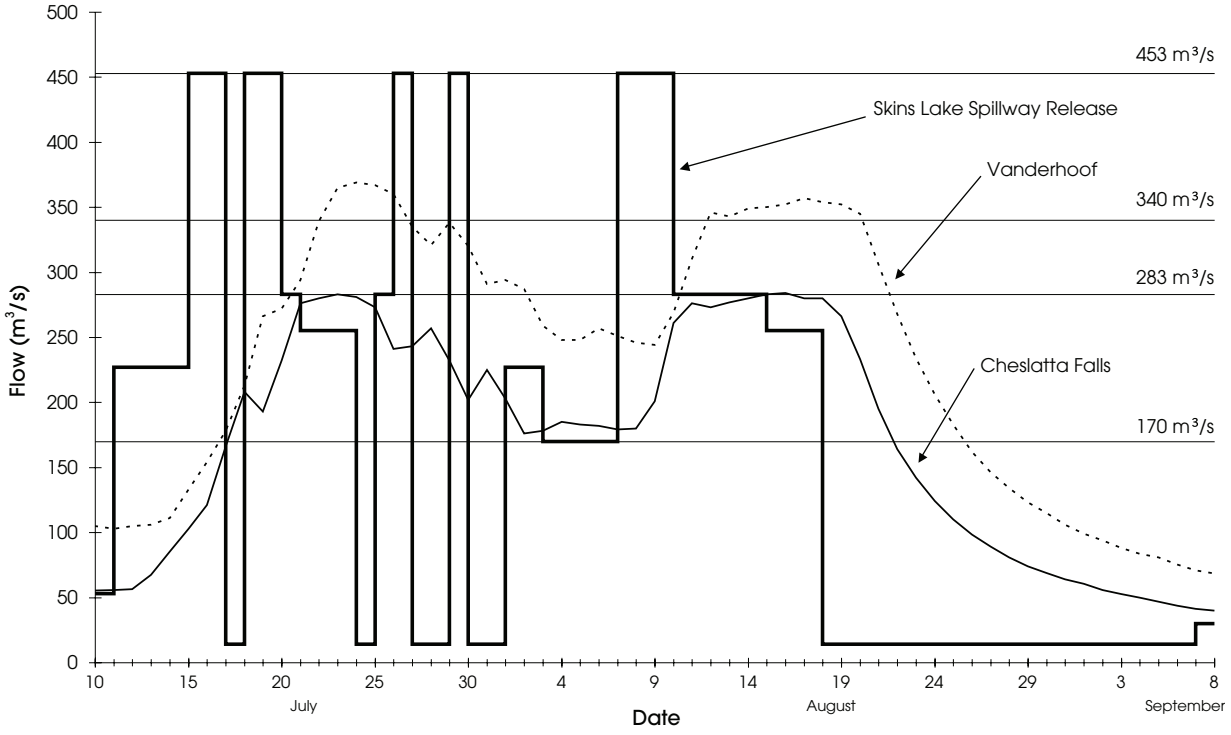


FIGURE 3

Skins Lake Spillway Releases and Flows in the Nechako River below Cheslatta Falls and at Vanderhoof, July 10 to September 8, 2004



RESULTS

Predicted and recorded mean daily water temperatures for the Nechako River above the Stuart River confluence, Skins Lake Spillway releases and changes in Skins Lake Spillway releases over the duration of the Project operational period are summarized in Table 2.

Mean daily water temperatures recorded during the control period in the Nechako River above the Stuart River confluence (Figure 2 and Table 3) exceeded 20.0°C (68.0°F) on thirteen days. The respective minimum and maximum mean daily water temperatures recorded during the control period were 18.7°C (65.7°F) on August 7 and 21.2°C (70.2°F) on August 19. A summary of mean daily water temperatures recorded during the Project in the Nechako River below Cheslatta Falls, near Fort Fraser and above the Stuart River confluence, and in the Nautley River near Fort Fraser is presented in Appendix B.

As outlined in the Methods section, Skins Lake Spillway releases required for water temperature control were regulated during the control period with the objective of maintaining flows in the Nechako River below Cheslatta Falls between 170 m³/s (6,000 cfs) and 283 m³/s (10,000 cfs) and flows at Vanderhoof at or below 340 m³/s (12,000 cfs).

Skins Lake Spillway releases and their corresponding flows in the Nechako River below Cheslatta Falls and at Vanderhoof are plotted in Figure 3. Daily Skins Lake Spillway releases, flows in the Nechako River below Cheslatta Falls and at Vanderhoof, and Nautley River flows are tabulated in Appendix C. A record of Skins Lake Spillway release changes during the Project and the reasoning behind them is presented in Table 4.

During the control period, mean daily flows measured in the Nechako River below Cheslatta Falls (based on preliminary WSC data from the WSC data collection platform at Bert Irvine's Lodge) ranged between a maximum of 284 m³/s (10,030 cfs) on August 16 and a minimum of 176 m³/s (6,220 cfs) on August 2. Mean daily flows measured in the Nechako River at Vanderhoof ranged between a maximum of 369 m³/s (13,030 cfs) on July 24 and a minimum of 244 m³/s (8,620 cfs) on August 9. Following the control period, the mean daily flow in the Nechako River below Cheslatta Falls was reduced to 43.6 m³/s (1,540 cfs) by September 6.

TABLE 3 **Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, July 10 to August 20, 2004**

Date	Water Temperature (°C)	Date	Water Temperature (°C)
10-Jul	17.7	1-Aug	19.7
11-Jul	18.6	2-Aug	20.1
12-Jul	19.6	3-Aug	20.0
13-Jul	19.9	4-Aug	19.9
14-Jul	20.4	5-Aug	19.7
15-Jul	21.8	6-Aug	18.9
16-Jul	22.5	7-Aug	18.7
17-Jul	21.9	8-Aug	18.8
18-Jul	21.1	9-Aug	19.1
19-Jul	20.6	10-Aug	19.4
20-Jul	19.7	11-Aug	20.1
21-Jul	19.2	12-Aug	20.0
22-Jul	19.3	13-Aug	20.3
23-Jul	20.0	14-Aug	20.6
24-Jul	20.6	15-Aug	20.6
25-Jul	20.0	16-Aug	20.5
26-Jul	19.2	17-Aug	20.3
27-Jul	19.3	18-Aug	20.6
28-Jul	20.0	19-Aug	21.2
29-Jul	20.4	20-Aug	20.7
30-Jul	20.1		
31-Jul	19.9		

DISCUSSION

The discussion of the 2004 Summer Water Temperature and Flow Management Project has been divided into four sections. The first section reviews the collection and use of recorded field data. Variables measured include water temperature, flow, and meteorological data (recorded and forecast). The second section discusses occurrences of mean daily water temperatures in excess of 20.0°C (68.0°F) in the Nechako River above the Stuart River confluence. The third section discusses the volume of water used during the 2004 Summer Water Temperature and Flow Management Project. The fourth section provides a brief discussion of the application of the Project release criteria.

Recorded Data

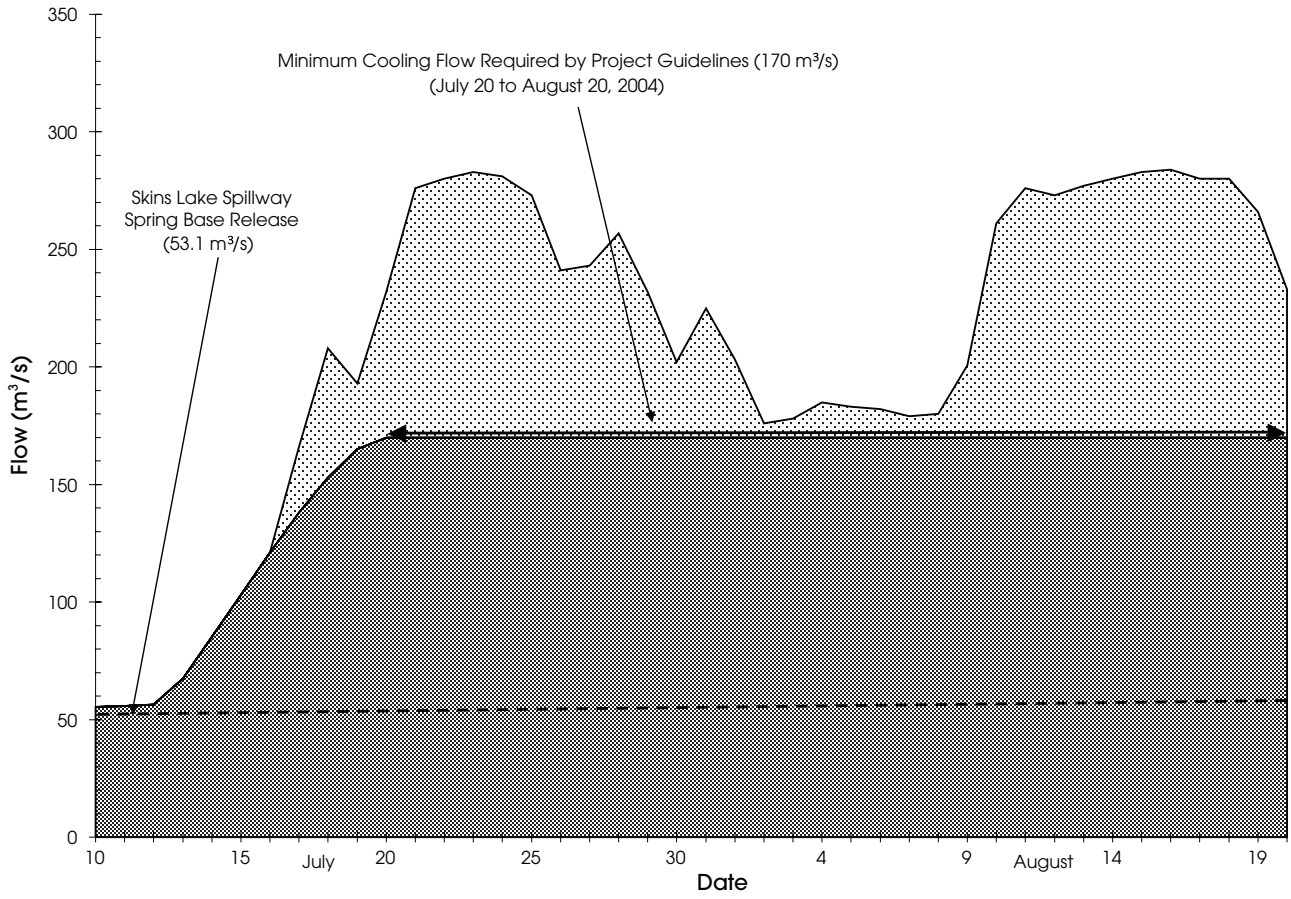
Triton's modelling procedure is based on the premise that the best way to forecast water temperatures is to initialise computations with recorded conditions. For this reason, the quality of the field data used in the modelling process directly affects the accuracy of the computed water temperatures. Therefore, data must be collected accurately and consistently to ensure that random errors are kept to a minimum. Consistency in data collection techniques also ensures a constant bias throughout the project.

In 2004, flow data obtained from gauging stations in the Nechako River below Cheslatta Falls, in the Nechako River at Vanderhoof and in the Nautley River near Fort Fraser appeared to be accurate.

TABLE 4 **Rationale for Skins Lake Spillway Release Changes, July 10 to September 7, 2004**

Date 2000	Old Setting (m^3/s)	New Setting (m^3/s)	Time of Change (hrs)	Reason for Changing SLS Release Setting
11-Jul	53.1	227	1600	To ensure base flow of 170 m^3/s in the Nechako River below Cheslatta Falls by July 20
15-Jul	227	453	2000	In response to a predicted warming trend
17-Jul	453	14.2	1400	In response to a predicted cooling trend
18-Jul	14.2	453	1600	In response to a predicted warming trend
20-Jul	453	283	2000	Flow control
21-Jul	283	255	1400	Flow control
24-Jul	255	14.2	1400	In response to a predicted cooling trend
25-Jul	14.2	283	1600	In response to a predicted warming trend
26-Jul	283	453	1600	In response to a predicted warming trend
27-Jul	453	283	0800	Flow control
27-Jul	283	14.2	1600	In response to a predicted cooling trend
29-Jul	14.2	453	1700	In response to a predicted warming trend
30-Jul	453	14.2	1600	In response to a predicted cooling trend
1-Aug	14.2	227	1600	Flow control
3-Aug	227	170	1400	Flow control
7-Aug	170	453	2000	In response to a predicted warming trend
10-Aug	453	14.2	1000	Flow control
10-Aug	14.2	283	2000	Flow control
15-Aug	283	255	1300	Flow control
18-Aug	255	14.2	1200	To achieve spawning flow in the Nechako River below Cheslatta Falls by early September
7-Sep	14.2	30.0	0800	To achieve spawning flow in the Nechako River below Cheslatta Falls

FIGURE 4 **Flows in the Nechako River below Cheslatta Falls Resulting from Skins Lake Spillway Releases, July 10 to August 20, 2004**



Flows in the Nechako River below Cheslatta Falls and at Vanderhoof responded as expected in response to Skins Lake Spillway releases. The Nautley River flow regime was well below average throughout the Project operational period. The ability to obtain hourly stage data from the gauging stations located on the Nechako River below Cheslatta Falls and at the west end of Cheslatta Lake proved very useful in verifying the daily predictions of the flow routing model and accounting for changes in the local inflow to the Cheslatta/Murray Lakes system.

As previously stated, spot and corresponding recorder (thermograph) water temperatures were collected in the Nechako River at Fort Fraser (upstream of the Nautley River), in the Nechako River above the Stuart River confluence and in the Nautley River during each site visit. The thermograph water temperatures were not consistently higher or lower than their associated spot temperatures. These data were used to adjust water temperatures following the method outlined in the Methods section of this report.

Recorded and forecast meteorological data were obtained daily from World Weatherwatch, a subconsultant to Triton. The forecast weather data were developed using recorded weather data acquired from the Atmospheric Environmental Service (AES) station at Prince George Airport and from the meteorological monitoring station installed by Triton at Fort Fraser. The recorded and forecast weather data were used to estimate water temperatures in the Nechako River below Cheslatta Falls and in the Nautley River for the current day and following four days. A listing of the recorded and forecast meteorological data is provided in Appendix D.

Occurrences of Water Temperatures in the Nechako River above the Stuart River Confluence Exceeding Water Temperature Criterion

Mean daily water temperatures recorded during the control period in the Nechako River above the Stuart River confluence exceeded 20.0°C (68.0°F) on thirteen days, July 24, 29, and 30, and August 2, 11 and 13 through 20. Prior to the water temperature control period, mean daily water temperatures in the Nechako River above the Stuart River confluence exceeded 20.0°C (68.0°F) on six consecutive days, July 14 to 19.

The first day in the control period when the temperature criterion was on July 24. At that time the flow in the Nechako River below Cheslatta Falls was at or near the maximum allowable level of 283 m³/s (10,000 cfs) in response to previous forecast warming conditions (a SLS release increase initiated on July 18 and maintained until July 24), and thus no further action could be taken.

The second instance the temperature criterion was exceeded occurred on July 29 and July 30 when the mean daily temperatures were recorded as 20.4°C (68.7°F) and 20.1°C (68.2°F), respectively. A few days prior, the SLS release was decreased to 14.2 m³/s (500 cfs) on July 24 in response to a forecast cooling trend, and then increased on July 25 and 26 in response to the next warming trend. However, the predicted water temperatures, based on the meteorological forecasts for July 27 and 28, indicated that the warming trend would peak on July 29 or 30, and would be followed by a cooling trend. The SLS release was decreased to 14.2 m³/s (500 cfs) on July 27 and maintained at that level on July 28.

The third instance the temperature criterion was exceeded occurred on August 2 when the mean daily temperature was recorded as 20.1°C (68.2°F). The forecast on July 29 indicated that a third warming event was to occur, and the SLS release was increased to 453 m³/s (16,000 cfs). However, the SLS release was subsequently reduced to 14.2 m³/s on July 30 as the forecast again indicated that the warming trend was expected to be weak and it would be followed by a cooling trend. The mean daily water temperature decreased steadily from 20.4°C (68.7°F) on July 29 to 19.7°C (67.5°F) on August 1, increased to 20.1°C (68.2°F) on August 2, and then decreased steadily to 18.7°C (65.7°F) (the minimum mean daily temperature recorded during the control period) on August 7.

The fourth instance the temperature criterion was exceeded occurred on August 11 and from August 13 to August 20. In response to a predicted warming trend, the SLS release was increased to 453 m³/s on August 7, and subsequently regulated to the end of the control period to achieve the maximum flow of 283 m³/s in the Nechako River below Cheslatta Falls. During this period, mean daily water temperatures increased from 18.7°C (65.7°F) on August 7 to 20.1°C (68.2°F) on August 11, decreased to 20.0°C (68.0°F) on August 12, varied between 20.3°C (68.5°F) on August 13 and 21.2°C (70.2°F) on August19, and then decreased to 20.7°C (69.3°F) on August 20. Note that, with the exception of August 19 and 20, from August 11 to the end of the control period, the flow in the Nechako River below Cheslatta Falls was at or near the maximum allowable level of 283 m³/s (10,000 cfs), and thus no further action could be taken. In addition, modelled flow and water temperatures indicated that, although the mean daily water temperatures in the Nechako River above the Stuart River (at Finmoore) were above 20.0°C (68.0°F) during the latter part of the control period, a reduction in the SLS release on August 18 would have little or no effect on the downstream water temperatures for August 19 and 20. The SLS release was thus decreased to 14.2 m³/s on August 18, and maintained at that level until early September to achieve the fall spawning flow for chinook salmon.

Volume of Water Used

Figure 4 presents the recorded flows in the Nechako River below Cheslatta Falls for the 2004 Summer Water Temperature and Flow Management Project. Also indicated is the minimum cooling flow of 170 m³/s (6,000 cfs) in the Nechako River below Cheslatta Falls, and the Skins Lake Spillway spring base release of 53.1 m³/s (1,875 cfs) as determined by the NFCP Technical Committee as part of the "Annual Water Allocation" defined in the 1987 Settlement Agreement (Anon. 1987).

The total volume of water released during the 2004 Summer Water Temperature and Flow Management Project operational period was 9,422.7 m³/s-d, (332,762 cfs-d). The volume released for cooling purposes was 7,270.4 m³/s-d (256,753 cfs-d), and is based on an assumed Skins Lake Spillway release of 53.1 m³/s (1,875 cfs) for the period July 10 to August 18, inclusive, with a reduction to 14.2 m³/s (500 cfs) until August 20. The average release during the operational period was 224.3 m³/s (7,923 cfs). Volume calculations are presented in Appendix E.

Application of the Summer Water Temperature and Flow Management Project Release Criteria

The Summer Water Temperature and Flow Management Project is very sensitive to the accuracy of meteorological forecasting. If an increase or decrease in temperature occurs over a prolonged period of time (three or four days), inaccurate meteorological forecasts may predict the reversal of the temperature change prematurely. In these instances, it may be required to exercise judgment when applying the Summer Water Temperature and Flow Management Project release criteria used with the three water temperature trends. This judgment is based on experience gained in the operation of the Summer Water Temperature and Flow Management Project since 1984 and may result in exceptions to the decision based on strict adherence to the release criteria. No exceptions were made to the application of the release criteria during the entire operational period.

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APPENDIX A

Numerical Example of Water Temperature Trend Calculation

APPENDIX A Numerical Example of Water Temperature Trend Calculation

From data for July 16 date of operation (Table A1).

1. Observed Trend

   The observed trend is up by 1.4°C from 20.4°C (J14) to 21.8°C (J15). Take the previous day's recorded temperature 21.8°C (J15) and extrapolate the trend for five days at 1.4°C. The observed trend shows that the water temperature could potentially reach 21.8°C + 5(1.4°C) = 28.8°C.

2. Predicted Trend

   The predicted trend is the difference between the previous day's calculated water temperature (J15) and the fifth day predicted water temperature (J20). The predicted trend is down from 22.2°C to 19.2°C with the potential to reach 19.2°C.

3. Forecast Trend

   The forecast trend for the current day of July 16 is based on the first, second and third day forecasts.

July 16	22.3 to 22.8	=	up	0.5°C
July 17	21.6 to 21.9	=	up	0.3°C
uly 18	20.6 to 20.8	=	up	0.2°C
Mean of 3 differences		=	up	0.3°C

   This mean of 0.3°C is added to the fifth day predicted water temperature to give 19.2°C + (0.3°C) = 19.5°C.

Table A1: Predicted and Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, 2004

	JULY										
Date	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
5th Day's Predicted Water Temperatureat Date + 4 Days					20.4	20.6	20.8	20.2	19.8	19.8	19.2
4th Day's Predicted Water Temperatureat Date + 3 Days				19.7	20.1	21.0	20.9	20.4	20.6	19.9	
3rd Day's PredictedWater Temperatureat Date + 2 Days			19.2	19.3	20.7	21.4	21.2	21.6	20.8		
2nd Day's Predicted Water Temperatureat Date + 1 Day		18.7	18.9	20.1	21.2	21.6	22.3	21.9			
Current Day's Predicted Water Temperatureat Date	18.2	18.7	19.6	20.8	21.1	22.0	22.8				
Previous Day's Calculated Water Temperatureat Date - 1 Day	18.1	19.1	19.8	20.8	21.2	22.2					
Previous Day's Recorded Water Temperatureat Date - 1 Day	17.7	18.6	19.6	19.9	20.4	21.8					
Current Day's Skins Lake Spillway Release at Date (m^3/s)	53.1	53.1 to 226.533 @ 1600 hrs	227	227	227	227 to 453.065 @ 2000 hrs	453				

APPENDIX B

Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2004

APPENDIX B Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2004

	Nechako River			Nautley		Nechako River			Nautley
Date	Cheslatta Falls (°C)	Fort Fraser (°C)	above the Stuart River (°C)	Fort Fraser (°C)	Date	Cheslatta Falls (°C)	Fort Fraser (°C)	above Stuart River (°C)	Fort Fraser (°C)
10-Jul	17.2	18.3	17.7	18.7	1-Aug	18.1	19.8	19.7	20.3
11-Jul	17.2	18.7	18.6	18.4	2-Aug	18.2	20.3	20.1	20.5
12-Jul	17.5	19.5	19.6	19.1	3-Aug	18.3	20.2	20.0	19.7
13-Jul	17.7	19.6	19.9	19.2	4-Aug	18.1	19.5	19.9	20.1
14-Jul	17.9	20.8	20.4	20.0	5-Aug	18.1	18.9	19.7	19.7
15-Jul	17.8	21.8	21.8	20.3	6-Aug	18.0	18.8	18.9	19.8
16-Jul	18.3	18.6	22.5	20.0	7-Aug	17.8	18.7	18.7	19.7
17-Jul	18.0	19.4	21.9	19.9	8-Aug	17.8	19.1	18.8	19.7
18-Jul	17.6	19.3	21.1	20.3	9-Aug	18.2	19.4	19.1	19.9
19-Jul	17.3	18.4	20.6	20.1	10-Aug	17.8	19.1	19.4	20.2
20-Jul	17.1	17.8	19.7	19.4	11-Aug	18.0	19.8	20.1	20.6
21-Jul	17.0	17.8	19.2	19.4	12-Aug	18.1	20.5	20.0	21.2
22-Jul	17.8	17.9	19.3	20.8	13-Aug	18.2	20.6	20.3	21.4
23-Jul	17.6	18.9	20.0	21.2	14-Aug	18.4	20.9	20.6	21.8
24-Jul	17.8	18.8	20.6	20.8	15-Aug	18.5	21.6	20.6	21.3
25-Jul	17.7	18.8	20.0	20.3	16-Aug	18.7	20.8	20.5	21.3
26-Jul	17.7	18.6	19.2	18.9	17-Aug	18.7	19.6	20.3	21.6
27-Jul	17.4	18.7	19.3	19.8	18-Aug	18.7	19.8	20.6	22.3
28-Jul	18.5	19.3	20.0	20.3	19-Aug	18.9	19.9	21.2	21.8
29-Jul	18.1	20.1	20.4	21.0	20-Aug	19.1	19.9	20.7	21.4
30-Jul	18.0	19.9	20.1	20.0					
31-Jul	18.1	19.7	19.9	20.1					

APPENDIX C

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2004

APPENDIX C

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2004)

Date	Skins Lake SpillwayRelease (m^3/s)	Nechako River		Nautley River Fort Fraser (m^3/s)
		Cheslatta Falls (m^3/s)	At Vanderhoof (m^3/s)	
10	53.1	55.3	105.0	27.5
11	53.1 to 227 @ 1600 hrs	55.8	103.0	27.8
12	227	56.4	105.0	29.2
13	227	67.4	106.0	29.2
14	227	85.2	111.0	29.2
15	227 to 453 @ 1600 hrs	103.0	133.0	29.2
16	453	121.0	154.0	29.6
17	453 to 14.2 @ 1600 hrs	166.0	178.0	29.2
18	14.2 to 453 @ 1600 hrs	208.0	213.0	29.2
19	453	193.0	266.0	29.2
20	453 to 283 @ 2000 hrs	232.0	272.0	29.6
21	283 to 255 @ 1400 hrs	276.0	294.0	30.1
22	255	280.0	339.0	29.6
23	255	283.0	365.0	29.2
24	255 to 14.2 @ 1600 hrs	281.0	369.0	28.8
25	14.2 to 283 @ 1600 hrs	273.0	367.0	29.2
26	283 to 453 @ 1600 hrs	241.0	360.0	30.0
27	453 to 283 @ 0800 hrs 283 to 14.2 @ 1600 hrs	243.0	335.0	28.1
28	14.2	256.8	321.0	27.7
29	14.2 to 453 @ 1600 hrs	232.0	338.0	27.3
30	453 to 14.2 @ 1600 hrs	202.0	320.0	27.3
31	14.2	225.0	291.0	26.2
1	14.2 to 227 @ 1600 hrs	203.0	294.0	25.2
2	227	176.0	287.0	24.8
3	227 to 170 @ 1600 hrs	178.0	259.0	24.5
4	170	185.0	248.0	23.8
5	170	183.0	248.0	24.1

APPENDIX C (cont.) **Mean Daily Skins Lake Spillway Releases and Flows** in the Nechako and Nautley Rivers, 2004)

Date	Skins Lake SpillwayRelease (m^3/s)	Nechako River		Nautley River Fort Fraser (m^3/s)
		Cheslatta Falls (m^3/s)	At Vanderhoof (m^3/s)	
6	170	182.0	257.0	23.4
7	170 to 453 @ 2000 hrs	179.0	251.0	23.1
8	453	180.0	246.0	22.8
9	453	200.7	244.0	20.7
10	453 to 14.2 @ 1000 hrs 14.2 to 283 @ 2000 hrs	261.0	269.0	21.8
11	283	276.0	310.0	20.0
12	283	273.0	346.0	21.2
13	283	277.0	343.0	20.8
14	283	280.0	349.0	20.2
15	283 to 255 @ 1300 hrs	283.0	350.0	19.9
16	255	284.0	352.0	19.2
17	255	280.0	357.0	18.9
18	255 to 14.2 @ 1130 hrs	280.0	354.0	19.2
19	14.2	266.0	352.0	18.6
20	14.2	233.0	345.0	18.0
21	14.2	195.0	306.0	
22	14.2	164.0	268.0	
23	14.2	142.0	234.0	
24	14.2	124.0	206.0	
25	14.2	110.0	183.0	
26	14.2	98.4	162.0	
27	14.2	88.9	146.0	
28	14.2	80.7	134.0	
29	14.2	74.1	123.0	
30	14.2	68.8	115.0	
31	14.2	64.0	106.0	
1	14.2	60.6	98.9	
2	14.2	55.8	93.9	
3	14.2	52.7	88.0	
4	14.2	49.8	83.4	
5	14.2	46.8	80.8	
6	14.2	43.6	75.4	
7	14.2 to 30.0 @ 0800 hrs	41.2	70.8	
8	30	39.8	68.6	

APPENDIX D
Recorded and Forecast Meteorological Data

13.70	428.00	0.89	10.30	3.50	93.20	81.50	9 07 04
14.40	465.00	0.63	9.30	11.30	93.10	79.30	10 07 04
15.50	387.00	0.78	10.90	9.80	93.30	82.40	
15.20	529.00	0.46	9.10	4.70	93.50	78.20	
17.80	604.00	0.34	9.60	3.30	93.60	74.60	
18.40	555.00	0.42	10.40	3.80	93.50	76.90	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 10/04

15.30	352.60	0.59	9.10	10.40	93.10	70.90	10 07 04
14.80	350.00	0.80	10.90	10.20	93.35	78.00	11 07 04
14.80	520.00	0.52	9.10	4.70	93.55	74.00	
17.40	580.00	0.45	10.00	3.60	93.50	70.00	
18.00	575.00	0.45	10.00	4.30	93.40	70.00	
17.00	500.00	0.50	10.00	5.90	93.34	65.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 11/04

15.90	452.70	0.89	10.30	8.60	93.40	71.50	11 07 04
15.60	440.00	0.70	11.00	6.20	93.65	74.00	12 07 04
17.80	540.00	0.55	10.40	4.60	93.45	64.00	
18.40	565.00	0.50	10.30	4.60	93.40	65.00	
18.00	525.00	0.50	11.00	6.50	93.34	65.00	
17.40	460.00	0.70	11.00	12.00	93.10	66.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 12/04

16.50	352.80	0.88	11.50	3.30	93.70	71.80	12 07 04
17.80	490.00	0.60	12.50	6.00	93.55	71.00	13 07 04
18.50	550.00	0.50	10.40	5.00	93.47	62.00	
18.50	530.00	0.55	10.50	6.80	93.40	62.00	
18.00	430.00	0.60	11.20	13.00	93.10	64.00	
17.00	450.00	0.60	10.10	9.00	92.78	65.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 13/04

17.00	488.30	0.76	12.90	6.60	93.60	78.90	13 07 04
18.50	575.00	0.50	10.70	5.00	93.60	60.00	14 07 04
18.50	530.00	0.55	10.30	7.30	93.34	61.00	
17.80	445.00	0.60	11.00	12.00	93.00	64.00	
17.20	445.00	0.60	10.10	8.00	92.78	65.00	
17.00	380.00	0.80	12.50	11.50	92.65	75.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 14/04

17.70	666.80	0.39	10.30	3.30	93.80	67.70	14 07 04
19.20	580.00	0.50	11.30	8.00	93.42	60.00	15 07 04
18.40	490.00	0.55	11.50	11.00	93.10	64.00	
17.90	480.00	0.55	10.60	8.50	93.00	62.00	
17.50	400.00	0.75	12.90	12.50	92.75	74.00	
16.50	330.00	0.85	12.80	13.00	93.00	79.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 15/04

20.20	581.70	0.36	11.10	6.50	93.40	60.70	15 07 04
18.80	510.00	0.55	11.50	8.00	93.30	62.00	16 07 04
19.00	500.00	0.50	10.00	6.00	93.50	65.00	
17.90	420.00	0.65	11.90	11.00	92.00	70.00	
16.50	330.00	0.85	12.50	12.00	92.70	79.00	
16.80	420.00	0.60	11.50	10.00	93.00	72.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 16/04

19.70	456.97	0.64	11.40	5.50	93.40	59.90	16 07 04
19.00	470.00	0.50	10.00	5.50	93.50	62.00	17 07 04
18.20	420.00	0.65	11.50	7.00	92.80	65.00	
16.70	350.00	0.80	12.50	8.00	92.70	80.00	
16.50	420.00	0.65	11.00	10.00	93.10	78.00	
16.20	520.00	0.40	9.50	9.00	93.60	70.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 17/04

18.80	514.80	0.62	10.70	1.50	93.50	62.10	17 07 04
18.50	440.00	0.65	12.20	3.00	93.20	65.00	18 07 04
17.00	370.00	0.80	12.50	7.00	92.70	80.00	
16.20	430.00	0.60	11.00	8.00	93.20	75.00	
16.50	530.00	0.40	9.50	8.00	93.70	68.00	
18.20	590.00	0.30	8.50	2.00	94.20	55.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 18/04

19.50	479.40	0.68	12.60	5.00	93.20	65.00	18 07 04
18.50	390.00	0.80	13.50	6.00	93.00	78.00	19 07 04
16.80	450.00	0.65	10.80	8.00	93.10	80.00	
16.50	560.00	0.30	9.50	5.00	93.80	68.00	
18.20	590.00	0.30	8.50	3.00	94.20	55.00	
18.60	590.00	0.20	9.00	3.00	93.90	57.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 19/04

18.90	397.90	0.86	13.40	7.80	93.00	72.80	19 07 04
16.50	420.00	0.75	10.80	8.00	93.20	78.00	20 07 04
16.60	570.00	0.30	10.00	5.00	93.90	65.00	
18.20	590.00	0.20	9.00	3.00	94.20	58.00	
18.60	610.00	0.20	10.00	2.00	94.00	55.00	
19.90	600.00	0.20	11.00	3.00	93.70	57.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 20/04

15.20	403.40	0.88	11.00	10.50	93.30	78.60	20 07 04
16.10	540.00	0.70	10.00	7.00	94.10	72.00	21 07 04
18.30	600.00	0.20	9.00	3.00	94.30	60.00	
19.20	610.00	0.20	10.00	2.00	93.90	57.00	
20.30	600.00	0.20	11.00	3.00	93.50	57.00	
18.50	580.00	0.40	11.50	5.00	93.20	60.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 21/04

15.80	379.05	0.78	11.30	6.80	94.10	76.50	21 07 04
16.90	600.00	0.20	9.80	2.00	94.40	65.00	22 07 04
19.50	600.00	0.20	9.80	2.00	93.90	57.00	
20.50	590.00	0.30	10.50	3.00	93.40	57.00	
18.80	560.00	0.50	11.00	5.00	93.10	60.00	
16.00	450.00	0.70	8.00	12.00	93.40	75.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 22/04

17.10	645.30	0.18	10.50	3.30	94.40	68.80	22 07 04
19.20	630.00	0.20	12.20	2.00	94.00	62.00	23 07 04
20.50	600.00	0.30	10.80	4.00	93.40	57.00	
18.20	540.00	0.50	11.50	6.00	93.20	62.00	
16.00	430.00	0.70	8.50	12.00	93.50	75.00	
17.50	400.00	0.80	10.00	9.00	93.70	75.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 23/04

19.90	608.00	0.20	12.00	3.40	93.90	65.30	23 07 04
20.90	590.00	0.30	12.00	4.00	93.50	57.00	24 07 04
17.90	540.00	0.50	11.00	6.00	93.50	62.00	
15.80	430.00	0.65	8.50	11.00	93.70	72.00	
16.80	420.00	0.70	9.80	8.00	93.70	70.00	
18.00	550.00	0.40	10.00	3.00	93.50	65.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 24/04

20.50	373.30	0.29	11.40	5.60	93.40	60.80	24 07 04
17.80	500.00	0.58	9.00	12.50	93.75	58.00	25 07 04
15.60	450.00	0.60	8.20	12.00	93.85	66.00	
16.50	440.00	0.60	9.40	7.00	93.80	66.00	
18.00	550.00	0.40	10.00	3.00	93.60	62.00	
19.00	490.00	0.50	10.50	4.00	93.00	58.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 25/04

17.10	546.30	0.48	7.10	11.10	93.70	55.90	25 07 04
16.00	510.00	0.45	7.50	11.00	94.00	60.00	26 07 04
16.50	490.00	0.50	8.80	8.00	93.90	63.00	
18.50	540.00	0.45	9.30	4.00	93.60	58.00	
19.00	480.00	0.55	10.50	5.00	93.20	58.00	
17.50	440.00	0.60	9.50	9.50	93.10	59.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 26/04

16.90	597.70	0.40	5.90	7.60	94.00	50.50	26 07 04
16.80	560.00	0.35	8.00	6.00	94.00	59.00	27 07 04
19.00	550.00	0.40	9.10	5.00	93.65	54.00	
19.20	500.00	0.50	10.50	5.50	93.20	58.00	
17.80	460.00	0.55	9.50	10.00	93.10	59.00	
17.00	460.00	0.55	8.80	7.50	93.05	58.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 27/04

16.70	599.90	0.14	6.90	3.60	93.90	56.90	27 07 04
19.20	610.00	0.20	8.50	7.00	93.65	50.00	28 07 04
19.60	500.00	0.55	10.50	6.50	93.15	56.00	
17.50	440.00	0.60	10.00	11.00	93.00	61.00	
16.80	430.00	0.60	9.20	7.50	93.00	61.00	
16.80	350.00	0.80	11.50	8.00	92.95	71.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 28/04

19.30	626.90	0.29	8.80	4.90	93.60	55.50	28 07 04
20.00	525.00	0.45	11.50	7.80	93.30	58.00	29 07 04
17.50	470.00	0.55	9.50	10.00	93.10	59.00	
16.50	430.00	0.60	9.00	7.50	93.00	61.00	
15.80	340.00	0.80	11.00	7.50	93.00	73.00	
14.50	250.00	0.90	11.00	7.50	92.70	80.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 29/04

20.80	421.40	0.44	10.30	8.30	93.30	53.50	29 07 04
18.20	550.00	0.38	5.50	11.90	93.10	46.00	30 07 04
16.90	530.00	0.42	6.90	8.60	93.30	52.00	
17.30	415.00	0.58	8.40	4.70	93.20	60.00	
14.90	379.00	0.69	11.50	5.30	92.90	72.00	
14.50	335.00	0.78	11.20	7.20	92.80	75.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 30/04

19.00	623.00	0.22	5.70	9.30	93.30	43.00	30 07 04
16.70	593.00	0.20	4.90	5.20	93.40	54.00	31 07 04
17.10	514.00	0.43	7.80	3.10	93.30	59.00	
16.30	448.00	0.52	8.30	4.60	92.90	65.00	
15.20	354.00	0.67	10.70	4.80	93.00	71.00	
14.90	332.00	0.65	9.30	3.70	93.20	70.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED JUL 31/04

16.00	538.00	0.26	5.00	5.30	93.40	53.00	31 07 04
17.60	523.00	0.38	5.40	2.70	93.10	56.00	01 08 04
17.20	457.00	0.54	9.70	4.10	92.70	62.00	
15.70	313.00	0.71	10.90	5.60	93.00	72.00	
15.30	359.00	0.69	9.80	3.70	93.20	70.00	
15.90	412.00	0.58	8.60	5.20	93.10	67.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 01/04

16.00	565.00	0.44	6.60	4.00	93.40	58.00	01 08 04
17.90	505.00	0.57	8.10	3.20	92.80	60.00	02 08 04
15.80	397.00	0.69	10.20	5.80	93.10	69.00	
16.10	396.00	0.64	9.90	4.10	93.20	63.00	
16.30	413.00	0.61	9.10	4.80	93.00	60.00	
15.90	449.00	0.58	8.30	5.20	93.30	58.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 02/04

19.80	566.00	0.50	8.60	4.00	92.80	54.00	02 08 04
16.90	368.00	0.74	9.90	7.40	93.10	64.00	03 08 04
17.10	392.00	0.67	10.40	5.20	93.10	61.00	
16.80	384.00	0.69	9.70	9.30	92.80	64.00	
15.50	413.00	0.62	8.40	9.80	93.20	60.00	
16.40	481.00	0.51	7.90	4.70	93.90	53.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 03/04

17.10	280.00	0.83	10.40	6.20	93.30	65.60	03 08 04
16.10	480.00	0.45	10.20	3.00	93.20	68.00	04 08 04
15.50	350.00	0.80	10.40	6.00	92.90	72.00	
15.00	390.00	0.70	9.00	4.00	92.80	67.00	
16.00	480.00	0.50	8.50	6.00	93.00	60.00	
17.00	520.00	0.48	8.00	3.00	93.10	55.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 04/04

15.40	494.00	0.57	10.80	4.80	93.20	76.00	04 08 04
15.00	220.00	0.90	12.50	3.00	93.00	85.00	05 08 04
15.00	350.00	0.80	10.50	7.00	93.10	74.00	
15.30	380.00	0.70	9.00	6.00	93.70	70.00	
16.30	520.00	0.40	8.00	4.00	93.90	59.00	
17.00	600.00	0.30	7.50	4.00	93.90	55.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 05/04

13.70	108.00	0.86	12.20	4.10	93.10	91.00	05 08 04
14.00	320.00	0.80	10.40	8.00	93.60	81.00	06 08 04
14.00	200.00	0.90	10.50	8.00	93.60	83.00	
15.00	400.00	0.60	8.80	4.00	93.80	68.00	
16.50	600.00	0.30	7.60	5.00	94.10	56.00	
18.00	600.00	0.20	8.00	4.00	93.80	52.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 06/04

14.80	465.00	0.85	9.90	7.10	93.40	74.60	06 08 04
12.30	330.00	0.88	7.20	6.00	93.80	73.00	07 08 04
14.50	450.00	0.60	6.80	6.00	94.20	60.00	
15.50	580.00	0.30	6.50	4.00	94.00	55.00	
16.50	600.00	0.20	6.80	3.00	93.90	53.00	
17.50	620.00	0.20	7.20	3.00	93.80	50.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 07/04

12.20	391.00	0.91	7.80	4.50	94.00	73.90	07 08 04
12.00	510.00	0.40	6.20	4.00	94.60	75.00	08 08 04
15.50	590.00	0.20	6.50	3.00	94.40	55.00	
16.80	610.00	0.20	6.80	3.00	94.00	50.00	
17.50	630.00	0.20	7.50	3.00	94.00	50.00	
17.80	600.00	0.30	8.50	4.00	93.70	55.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 08/04

12.40	452.40	0.34	7.00	3.50	94.80	73.00	08 08 04
14.30	590.00	0.30	6.80	4.00	94.50	68.00	09 08 04
16.00	620.00	0.20	6.50	4.50	94.10	55.00	
17.60	620.00	0.30	8.00	3.00	93.90	52.00	
18.00	600.00	0.30	8.50	3.50	93.60	52.00	
17.60	550.00	0.50	9.00	5.00	93.40	60.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 09/04

15.00	609.90	0.28	5.90	6.00	94.50	62.20	09 08 04
16.70	650.00	0.10	6.20	3.00	94.10	52.00	10 08 04
18.00	630.00	0.20	7.80	3.00	93.90	52.00	
18.60	580.00	0.30	8.50	3.50	93.70	55.00	
18.20	550.00	0.50	9.00	5.00	93.50	60.00	
17.80	510.00	0.60	9.20	5.00	93.60	62.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 10/04

17.00	544.70	0.17	8.10	1.70	94.10	53.90	10 08 04
19.20	630.00	0.20	9.90	3.00	93.90	52.00	11 08 04
19.40	590.00	0.25	9.50	3.50	93.70	55.00	
19.40	570.00	0.40	9.10	4.00	93.60	58.00	
19.70	530.00	0.50	9.50	5.00	93.50	60.00	
20.50	570.00	0.35	10.20	3.00	93.30	60.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 11/04

19.90	545.10	0.29	11.50	4.00	93.90	62.50	11 08 04
20.00	590.00	0.25	10.80	4.00	93.60	55.00	12 08 04
20.00	570.00	0.35	9.80	4.00	93.50	55.00	
20.50	540.00	0.45	9.80	5.00	93.50	55.00	
20.70	540.00	0.40	10.60	5.00	93.40	56.00	
19.70	480.00	0.55	11.50	7.00	93.80	59.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 12/04

20.00	559.00	0.18	11.10	7.20	93.60	61.80	12 08 04
21.00	550.00	0.35	10.80	6.50	93.60	53.00	13 08 04
21.50	540.00	0.40	10.30	5.50	93.50	52.00	
20.90	500.00	0.50	11.00	6.00	93.20	54.00	
19.40	440.00	0.60	11.50	8.00	93.60	59.00	
19.00	420.00	0.60	11.50	12.00	93.70	62.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 13/04

20.50	539.20	0.22	11.70	4.30	93.70	61.00	13 08 04
22.50	560.00	0.30	11.80	11.00	93.60	53.00	14 08 04
21.50	480.00	0.50	11.60	8.00	93.30	54.00	
19.70	420.00	0.65	11.80	8.50	93.50	60.00	
19.50	420.00	0.65	11.50	10.00	93.60	61.00	
19.50	420.00	0.65	11.00	5.00	93.70	58.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 14/04

22.60	516.20	0.12	13.70	10.90	93.60	59.50	14 08 04
22.20	490.00	0.50	12.60	9.00	93.50	55.00	15 08 04
20.70	440.00	0.60	11.80	8.50	93.50	58.00	
19.50	400.00	0.70	11.50	9.00	93.50	60.00	
19.00	390.00	0.70	11.30	5.00	93.60	60.00	
18.50	440.00	0.60	10.50	4.50	93.40	60.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 15/04

22.00	507.80	0.29	12.60	9.70	93.70	57.00	15 08 04
21.70	500.00	0.40	11.60	8.00	93.70	55.00	16 08 04
20.50	430.00	0.65	11.60	9.00	93.50	58.00	
19.00	390.00	0.70	11.60	6.00	93.40	62.00	
18.80	440.00	0.60	11.00	4.50	93.30	61.00	
19.00	440.00	0.60	12.00	8.00	93.30	64.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 16/04

20.90	505.20	0.20	11.30	7.60	93.80	56.60	16 08 04
21.00	510.00	0.15	10.50	9.00	93.70	55.00	17 08 04
19.80	420.00	0.50	11.00	5.50	93.70	58.00	
19.20	420.00	0.60	11.20	5.00	93.50	62.00	
18.80	410.00	0.70	12.00	7.50	93.50	65.00	
18.00	420.00	0.65	10.50	5.00	93.20	60.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 17/04

22.00	525.30	0.12	10.40	9.00	93.70	50.10	17 08 04
20.80	480.00	0.35	11.50	6.00	93.80	56.00	18 08 04
20.30	430.00	0.55	11.00	5.00	93.60	60.00	
17.80	400.00	0.75	11.00	7.00	93.40	65.00	
17.00	340.00	0.85	11.50	5.00	93.10	68.00	
15.00	200.00	0.90	8.50	9.00	92.80	77.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 18/04

21.00	515.20	0.22	11.40	3.50	93.90	57.40	18 08 04
20.00	470.00	0.40	10.70	4.00	93.60	60.00	19 08 04
17.70	400.00	0.75	10.50	6.00	93.40	65.00	
15.50	320.00	0.80	10.50	6.50	93.20	68.00	
14.00	200.00	0.90	8.00	11.00	92.70	80.00	
14.50	490.00	0.40	7.50	8.00	92.60	70.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 19/04

20.30	514.50	0.35	10.30	3.30	93.60	57.80	19 08 04
17.40	420.00	0.62	9.40	5.40	93.20	60.00	20 08 04
14.80	400.00	0.60	8.00	12.00	92.90	65.00	
12.50	300.00	0.72	7.00	15.00	92.50	70.00	
12.80	340.00	0.70	7.20	10.00	92.20	70.00	
13.20	380.00	0.60	7.40	6.00	92.30	70.00	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

WORLD WEATHERWATCH FORECAST ISSUED AUG 20/04

APPENDIX E

Summer Water Temperature and Flow Management Project
Reservoir Release Volume Calculations for
July 10 to August 20, 2004

APPENDIX E

Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations for July 10 to August 20, 2004

Summer Water Temperature and Flow Management Project Base Release Volume = (JD 230 - JD 190) * 49.0 + (JD 232 - JD 230) * 14.16 = 1,988.3 m³/s*days

Time period (Julian Day)	Time (hrs)	Flow Rate (m³/s)	Volume (m³/s*hrs)
July 10 (191) @ 2400 hrs to July 11 (192) @ 1600 hrs	40.0	53.1	2,124
July 11 (192) @ 1600 hrs to July 15 (196) @ 2000 hrs	100.0	226.5	22,650
July 15 (196) @ 2000 hrs to July 17 (198) @ 1300 hrs	41.0	453.1	18,576
July 17 (198) @ 1300 hrs to July 18 (199) @ 1600 hrs	27.0	14.2	382
July 18 (199) @ 1600 hrs to July 20 (201) @ 2000 hrs	52.0	453.1	23,560
July 20 (201) @ 2000 hrs to July 21 (202) @ 1400 hrs	18.0	283.2	5,097
July 21 (202) @ 1400 hrs to July 24 (205) @ 1400 hrs	72.0	254.9	18,353
July 24 (205) @ 1400 hrs to July 25 (206) @ 1600 hrs	26.0	14.2	368
July 25 (206) @ 1600 hrs to July 26 (207) @ 1600 hrs	24.0	283.2	6,796
July 26 (207) @ 1600 hrs to July 27 (208) @ 0800 hrs	16.0	453.1	7,249
July 27 (208) @ 0800 hrs to July 27 (208) @ 1600 hrs	8.0	283.2	2,265
July 27 (208) @ 1600 hrs to July 29 (210) @ 1700 hrs	49.0	14.2	694
July 29 (210) @ 1700 hrs to July 30 (211) @ 1600 hrs	23.0	453.1	10,421
July 30 (208) @ 1600 hrs to August 1 (213) @ 1600 hrs	48.0	14.2	680
August 1 (213) @ 1600 hrs to August 3 (215) @ 1400 hrs	46.0	226.5	10,419
August 3 (215) @ 1400 hrs to August 7 (220) @ 2000 hrs	102.0	169.9	17,330
August 7 (219) @ 2000 hrs to August 10 (222) @ 1000 hrs	62.0	453.1	28,090
August 10 (222) @ 1000 hrs to August 10 (222) @ 2000 hrs	10.0	14.2	142
August 10 (222) @ 2000 hrs to August 15 (227) @ 1300 hrs	113.0	283.2	32,002
August 15 (227) @ 1300 hrs to August 18 (230) @ 1200 hrs	71.0	254.9	18,098
August 18 (230) @ 1200 hrs to August 20 (232) @ 2400 hrs	60.0	14.2	850
Total	**1,008 (42 days)**		**226,144**

Total Release Volume
= 226,144 m³/s*hrs
= 9,422.7 m³/s*days
= 332,762 cfs*days

Volume Released for Cooling Purposes
= Total Volume - Base Volume
= 9,422.7 - 2,152.3
= 7,270.4 m³/s*days
= 256,753 cfs*days

Average Release over Summer Management Period (July 10 to August 20, 2003)
= 9,422.7 m³/s*days / 42 days
= 224.3 m³/s
= 7,922.9 cfs